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CERTIFICATION

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N, hereby certify that I am the translator of the
companying certified official copy of the documents in respect
of application for a patent filed in Japan on April 20, 1990
the official certificate attached thereto, and certify
the following is a true and correct translation to the best
knowledge and belief.

T. Motoyama

Tokihiro MOTOYAMA

ated this 12th day of November

T. Motoyama

PATENT OFFICE
JAPANESE GOVERNMENT

This is to certify that the annexed is a true copy
of the following application as filed with this Office.

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Application Number : (Hei.) 2-105772

Applicant(s) : NIPPON OIL CO., LTD.

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Commissioner,

Patent Office Satoshi UEMATSU

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PETITION FOR PATENT 1

April 20, 1990

To Commissioner of the Patent Office

Fumitake YOSHIDA

1. Title of the Invention:

REFRIGERATOR OILS FOR USE WITH CHLORINE-FREE TYPE HALOGENOCARBON REFRIGERANTS

2. Number of claims 1

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6. List of Attached Documents:

(1) Specification	1 copy
(2) Duplicate of the Petition	1 copy
(3) Power of Attorney	1 copy

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SPECIFICATION

1. Title of the Invention:

REFRIGERATOR OILS FOR USE WITH CHLORINE-FREE TYPE
HALOGENOCARBON REFRIGERANTS

2. What is claimed is:

1. A refrigerator oil for use in compressors using
therein a chlorine-free type halogenocarbon as a
refrigerant, comprising as a major component
a polyol ester obtained by the synthesis of, as raw
materials, (a) a neopentyl type polyhydric alcohol having 5-
6 carbon atoms and 3-4 hydroxyl groups, (b) a monocarboxylic
acid and (c) a dicarboxylic acid.

3. Detailed description of the Invention

[Field of the Invention]

This invention relates to a lubricating oil for
compressors of refrigerators using therein a chlorine-free
type halogenocarbon as a refrigerant (the oil being
hereinafter referred to as "a refrigerator oil for use with
a hydrogen-containing halogenocarbon refrigerant") and, more
specifically, it relates to such a refrigerator oil which

comprises a ester obtained by the synthesis of specific raw materials as a major component and is superior in various properties.

[Prior Art and Problems to be solved by the Invention]

Generally, naphthenic mineral oils, paraffinic mineral oils, alkylbenzenes, polyglycolic oils and mixtures thereof, which have each a kinematic viscosity of 10 - 200 cSt at 40°C, as well as said oils incorporated with suitable additives have been used as refrigerator oils.

On the other hand, chlorofluorocarbons (CFCS) type refrigerants, such as CFC-11, CFC-12, CFC-115 and HCFC-22, have been used for refrigerators.

Of these CFCS, CFCS such as CFC-11, CFC-12 and CFC-115, which are obtained by substituting all the hydrogen atoms of hydrocarbons thereof by halogen atoms including chlorine atoms, may lead to the destruction of the ozone layer, and therefore, the use of the CFCS has been controlled. Accordingly, chlorine-free type halogenocarbons, such as HFC-134a and HFC-152a, have been being used as substitutes for CFCs. HFC-134a is especially hopeful as a substitute refrigerant since it is similar in thermodynamic properties to CFC-12 which has heretofore been used in many kinds of refrigerators of home cold-storage chests, air-conditioners, car air-conditioners and the like.

Refrigerator oils require various properties, among which their compatibility with refrigerants is extremely

important in regard to lubricity and system efficiency in refrigerators. However, conventional refrigerator oils comprising, as the base oils, naphthenic oils, paraffinic oils, alkylbenzenes and the like, are hardly compatible with chlorine-free type halogenocarbons such as HFC-134a. Therefore, if said conventional refrigerator oils are used in combination with HFC-134a, the resulting mixture will separate into two layers at normal temperature thereby to degrade the oil-returnability which is the most important within the refrigeration system and cause various troubles such as a decrease in refrigeration efficiency, the deterioration of lubricity and the consequent seizure of the compressor within the system whereby the refrigerator oils are made unsuitable for use as such.

The present inventors developed polyglycolic refrigerator oils which have excellent compatibility with HFC-134a as compared with conventional known refrigerator oils, and filed applications for patents for the thus developed polyglycolic refrigerator oils (Japanese Pat. Appln. Laid-Open Gazettes Nos. hei. 1-256594 and hei. 1-274191). Further, U.S. Patent No. 4,755,316 discloses polyglycolic refrigerator oils which are compatible with HFC-134a. It has been found, however, that the polyglycolic oils raise problems as to their high compatibility with water and inferior electrical insulating property.

On the other hand, refrigerator oils used in compressors of home refrigerators and the like are required

to have a high electrical insulating property. Among the known refrigerator oils, alkylbenzenes and the mineral oils have the highest insulating property, but they are hardly compatible with chlorine-free type halogenocarbons such as HFC-134a as mentioned above. Therefore, there had been developed no refrigerator oils having both high compatibility with chlorine-free type halogenocarbons such as HFC-134a and a high insulating property before the accomplishment of the present invention.

The present inventors made various intensive studies in attempts to develop refrigerator oils which can meet the aforesaid requirements and, as the result of their studies, they found that esters obtained by the synthesis of specific raw materials have excellent compatibility with chlorine-free type halogenocarbons such as HFC-134a, and a high electrical insulating property as well as excellent lubricity. This invention is based on this finding.

The object of this invention is to provide refrigerator oils for use with chlorine-free type halogenocarbons refrigerants, the oils comprising as a major component (or a base oil) an ester obtained by the synthesis of specific raw materials and having excellent compatibility with chlorine-free type halogenocarbons such as HFC-134a, and a high electrical insulating property.

[Means of Solution to the Problems]

The refrigerator oil of the present invention is characterized in that it comprises as a major component a polyol ester prepared by the synthesis of, as raw materials, (a) a neopentyl type polyhydric alcohol having 5-6 carbon atoms and 3-4 hydroxyl groups, (b) a monobasic carboxylic acid and (c) a dibasic carboxylic acid.

This invention will be explained in more detail hereunder.

The refrigerator oils of the present invention are those comprising as a major component a polyol ester prepared by the synthesis of, as raw materials, (a) a neopentyl type polyhydric alcohol having 5-6 carbon atoms and 3-4 hydroxyl groups, (b) a monobasic carboxylic acid and (c) a dibasic carboxylic acid.

The neopentyl type polyhydric alcohols (a) having 5-6 carbon atoms and 3-4 hydroxyl groups are illustrated by trimethylolethane, trimethylolpropane and pentaerythritol.

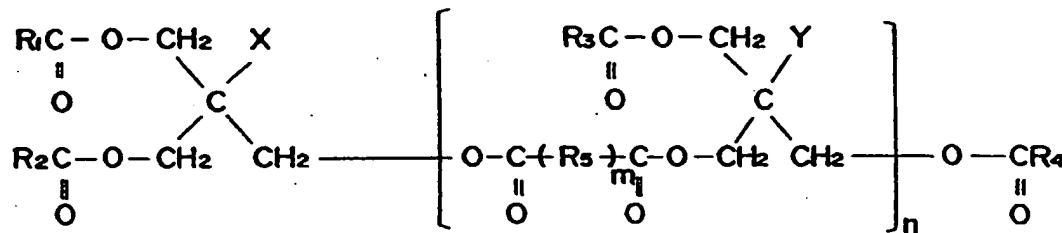
The monocarboxylic acids (b) preferably used herein are those having 2-15 carbon atoms and are exemplified by acetic acid, propionic acid, butanoic acid, pentanoic acid, hexanoic acid, heptanoic acid, octanoic acid, nonanoic acid, decanoic acid, undecanoic acid, dodecanoic acid, tridecanoic acid, tetradecanoic acid and pentadecanoic acid. These carboxylic acids may be either straight-chain or branched-chain ones, but it is preferable to use the latter having a branched-chain structure in an amount of not less than 50 mol%, more preferably not less than 60 mol%.

The dicarboxylic acids (c) used herein are those having 2-10 carbon atoms and are exemplified by saturated aliphatic dicarboxylic acids such as oxalic acid, malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, sebamic acid, methylmalonic acid, ethylmalonic acid, dimethylmalonic acid, methylsuccinic acid, 2,2-dimethylsuccinic acid, 2,3-dimethylsuccinic acid, 2-ethyl-2-methylsuccinic acid, 2-methylglutaric acid, 3-methylglutaric acid and 3-methyladipic acid; unsaturated aliphatic dicarboxylic acids such as maleic acid, fumaric acid, itaconic acid, citraconic acid and mesaconic acid; and aromatic dicarboxylic acids such as phthalic acid, terephthalic acid and isophthalic acid.

The esters are produced by the esterification reaction of the aforesaid component (a) with the component (b) and the component (c) under ordinary esterification conditions, for example, in the presence of an acid catalyst such as sulfuric acid and at an temperature of 100-180°C. The products obtained by the methods as mentioned above may be refined to remove the by-products and/or unreacted reactants, but the by-products and/or unreacted reactants may be present in small amounts in the refrigerator oils of the present invention as far as they do not impair the excellent performances thereof. In the present invention, although the esters are generally obtained in the form of a mixture thereof, a purified ester may be used singly. The

molecular weight of the ester according to the present invention is not particularly limited, but the number average molecular weight of the ester is in the range of preferably 200-3000, more preferably 300-2000, to improve the compressor in sealability. The kinematic viscosities of the esters according to the present invention are in the range of preferably 2-150 cSt, more preferably 5-100 cSt at 100°C.

The chemical structure of the ester according to the present invention is illustrated by the following general formula



wherein X and Y may be identical with, or different from, each other and are each an alkyl group having 1-4 carbon atoms or a group represented by the general formula $-\text{CH}_2-\overset{\text{O}}{\underset{\text{O}}{\text{O}}}-\text{CR}_6$; R_1-R_4 and R_6 may be identical with, or different from each other and are each an alkyl group having 4-15 carbon atoms; R_5 is an alkylene group having 1-8 carbon atoms; m is an integer of 0 or 1; and n is an integer of 1-5.

The refrigerator oil of the present invention may comprise as the only base oil the above esters and, as required, it may additionally comprise other base oils for

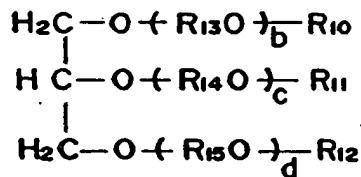
refrigerator oils. Among the other base oils, preferable ones are illustrated as follows:

a polyoxyalkylene glycol or an ether thereof represented by the general formula

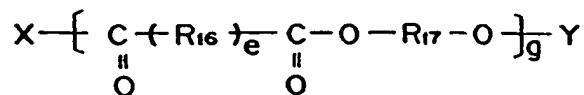


wherein R_7 and R_8 are each a hydrogen atom or an alkyl group having 1-18 carbon atoms, R_9 is an alkylene group having 2-4 carbon atoms and a is an integer of 5-70.

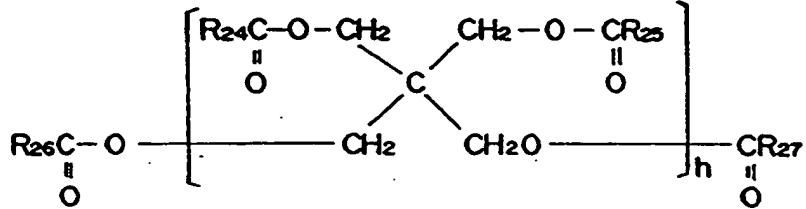
a polyoxyalkylene glycol glycerol ether represented by the general formula



wherein R_{10} - R_{12} are each a hydrogen atom or an alkyl group having 1-18 carbon atoms, R_{13} - R_{15} are each an alkylene group having 2-4 carbon atoms and b - d are each an integer of 5-7, an ester represented by the general formula



wherein X is a group represented by the general formula
 $-OR_{18}$ or $-O-R_{19}-O-C(=O)-R_{20}$, Y is a group represented by
the general formula $-C(=O)-R_{21}$ or $-C(=O)-R_{22}-C(=O)-OR_{23}$.
 R_{16} and R_{22} are each an alkylene group having 1-8 carbon
atoms, R_{17} and R_{19} are each an alkylene group having 2-16
carbon atoms, R_{18} and R_{23} are each an alkyl group having 1-
15 carbon atoms, R_{20} and R_{21} are each an alkyl group having
1-14 carbon atoms, e and f are each an integer of 0 or 1 and
g is an integer of 0-30; and
a pentaerythritol ester represented by the general formula



wherein R_{24} - R_{27} may be identical with, or different from,
each other and are each a group selected from the group
consisting of straight-chain alkyl groups having 3-11 carbon
atoms, branched-chain alkyl groups having 3-15 carbon atoms
and cycloalkyl groups having 6-12 carbon atoms, the
straight-chain alkyl groups being present in a ratio of not
more than 60 % of the total alkyl groups, and h is an integer
of 1-3.

These conventional oils may be used singly or jointly for adding to the refrigerator oil of this invention. Further, the refrigerator oil of this invention may be incorporated with paraffinic mineral oils, naphthenic mineral oils, poly α -olefins, alkylbenzenes and the like, but, in this case, the resulting mixed oil will be lowered in compatibility with chlorine-free type halogenocarbons.

The amount of these conventional base oils so incorporated is not particularly limited as far as the excellent performances of the refrigerator oil of this invention are not impaired, but the conventional base oils should be present in the resulting mixed oil in a ratio of usually less than 50 % by weight, preferably not more than 30 % by weight of the total amount of the mixed oil.

The refrigerator oil composition according to this invention may be incorporated further with at least one kind of a phosphorous compound selected from the group consisting of phosphoric esters, acid phosphoric esters, amine salts of acid phosphoric esters, chlorinated phosphoric esters and phosphorous esters, to improve the oil composition in wear resistance and load resistance. These phosphorous compounds are esters of phosphoric acid or phosphorous acid and an alkanol or a polyether type alcohol, or derivatives of the esters. The phosphoric esters are exemplified by tributyl phosphate, triphenyl phosphate and tricresyl phosphate. The acid phosphoric esters are exemplified by ditetradecyl acid phosphate, dipentadecyl acid phosphate, dihexadecyl acid

phosphate, diheptadecyl acid phosphate and dioctadecyl acid phosphate. The amine salts of acid phosphoric esters are exemplified by salts of the above acid phosphoric esters and amines such as methylamine, ethylamine, propylamine, butylamine, pentylamine, hexylamine, heptylamine, octylamine, dimethylamine, diethylamine, dipropylamine, dibutylamine, dipentylamine, dihexylamine, diheptylamine, dioctylamine, trimethylamine, triethylamine, tripropylamine, tributylamine, tripentylamine, trihexylamine, triheptylamine and trioctylamine. The chlorinated phosphoric esters are exemplified by tris-dichloropropyl phosphate, tris-chloroethyl phosphate, polyoxyalkylene bis[di(chloroalkyl)] phosphate and tris-chlorophenyl phosphate. The phosphorous esters are exemplified by dibutyl phosphite, tributyl phosphite, dipentyl phosphite, tripentyl phosphite, dihexyl phosphite, trihexyl phosphite, diheptyl phosphite, triheptyl phosphite, dioctyl phosphite, trioctyl phosphite, dinonyl phosphite, didecyl phosphite, diundecyl phosphite, triundecyl phosphite, didodecyl phosphite, tridodecyl phosphite, diphenyl phosphite, triphenyl phosphite, dicresyl phosphite, tricresyl phosphite and mixtures thereof. These phosphorous compounds may be added to the refrigerator oil in a ratio of 0.1-5.0 % by weight, preferably 0.2-2.0 % by weight, of the total amount of the refrigerator oil.

To further improve the refrigerator oil of the present invention in stability, it may be incorporated with

at least one kind of an epoxy compound selected from the group consisting of phenylglycidyl ether type epoxy compounds, glycidyl ester type epoxy compounds, epoxidized fatty acid monoesters and epoxidized vegetable oils. The said phenylglycidyl ether type epoxy compounds used herein include phenylglycidyl ether and alkylphenylglycidyl ethers. The said alkylphenylglycidyl ethers are those having 1 to 3 alkyl groups having 1 to 13 carbon atoms, among which are preferred those having an alkyl group having 4 to 10 carbon atoms, such as butylphenylglycidyl ether, pentylphenylglycidyl ether, hexylphenylglycidyl ether, heptylphenylglycidyl ether, octylphenylglycidyl ether, nonylphenylglycidyl ether and decylphenylglycidyl ether. The said glycidyl ester type epoxy compounds include phenylglycidyl esters, alkylglycidyl esters and alkenylglycidyl esters with glycidyl benzoate, glycidyl acrylate, glycidyl methacrylate and the like being preferred.

The epoxidized fatty acid monoesters include esters of an epoxidized fatty acid having 12 to 20 carbon atoms and an alcohol having 1 to 8 carbon atoms, phenol or an alkylphenol. In particular, butyl, hexyl, benzyl, cyclohexyl, methoxyethyl, octyl, phenyl or butylphenyl esters of epoxidized stearic acid may preferably be used.

The epoxidized vegetable oils include epoxidized compounds of vegetable oils such as soybean oil, linseed oil and cottonseed oil.

Among these epoxy compounds, the preferable ones include phenylglycidyl ether type epoxy compounds and epoxidized fatty acid monoesters with the former being more preferable. The most preferred are phenylglycidyl ether, butylphenylglycidyl ether and mixtures thereof.

In a case where these epoxy compounds are to be incorporated in the refrigerator oil of the present invention, it is desirable that they be incorporated therein in a ratio of 0.1-5.0 % by weight, preferably 0.2-2.0 % by weight, of the total amount of the refrigerator oil.

Of course, both of the aforementioned phosphorus compounds and epoxy compounds may be used jointly.

To further enhance the refrigerator oil of this invention in performances, the refrigerator oil may be incorporated, as required, with heretofore known additives for a refrigerator oil, which include phenol-type antioxidants such as di-tert.-butyl-p-cresol and bisphenol A; amine-type antioxidants such as phenyl- α -naphthylamine and N,N-di(2-naphthyl)-p-phenylenediamine; wear resistant additives such as zinc dithiophosphate; extreme pressure agents such as chlorinated paraffin and sulfur compounds; oiliness improvers such as fatty acids; antifoaming agents such as silicone-type ones; and metal inactivators such as benzotriazole. These additives may be used singly or jointly. The total amount of these additives added is ordinarily not more than 10 % by weight, preferably not more

than 5 % by weight, of the total amount of the refrigerator oil.

The refrigerator oils of this invention comprising the polyol esters as the major component should have such kinematic viscosity and pour point as those which are normally suitable for an ordinary refrigerator oil, but they should desirably have a pour point of not higher than -10°C, preferably -20°C to -80°C, to prevent them from solidification at a low temperature. Further, they should desirably have a kinematic viscosity of not less than 2cSt, preferably not less than 3cSt at 100°C, to keep the sealability of the compressor when used, while they should desirably have a kinematic viscosity of not more than 150cSt, preferably not more than 100cSt at 100°C, in view of their fluidity at a low temperature and the efficiency of heat exchange in the evaporator when used.

The refrigerator oils of the present invention are very excellent in compatibility with chlorine-free type halogenocarbons as compared with the heretofore known refrigerator oils. The chlorine-free type halogenocarbons are exemplified by 1,1,2,2-tetrafluoroethane (HFC-134), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1-difluoroethane (HFC-152a) and trifluoroethane (HFC-23) with HFC-134a being preferred.

Further, the refrigerator oils of the present invention are excellent ones which have not only high compatibility with the chlorine-free type halogenocarbons

and high electrical insulating property but also high lubricity and low hygroscopicity.

The refrigerator oils of the present invention may particularly preferably be used in refrigerators, air-conditioners, dehumidifiers, cold-storage chests, freezers, freeze and refrigeration warehouses, automatic vending machines, showcases, cooling units in chemical plants, and the like which have a reciprocating or rotary compressor. Further, the above refrigerator oils may also preferably be used in refrigerators having a centrifugal compressor.

[Examples]

This invention will be better understood by the following Examples and Comparative Examples.

Examples 1-2 and Comparative Examples 1-5

Refrigerator oils of this invention and comparative refrigerator oils of a conventional type are illustrated as follows:

[Example 1] An ester having an average molecular weight of 690 and a kinematic viscosity at 100°C of 9.6 cSt, obtained by the reaction of 2 moles of trimethylolpropane with 1 mole of succinic acid, 1 mole of glutaric acid, 2 moles of isopentanoic acid and 2 moles of iso-hexanoic acid

[Example 2] An ester having an average molecular weight of 880 and a kinematic viscosity at 100 °C of 12.7 cSt, obtained by the reaction of 2 moles of pentaerythritol with 1 mole of succinic acid, 1 mole of glutaric acid, 3 moles of iso-pentanoic acid and 3 moles of iso-hexanoic acid

[Comparative Example 1] A naphthenic mineral oil

[Comparative Example 2] A branched-chain type alkylbenzene (average molecular weight: about 300)

[Comparative Example 3] Polyoxypropylene glycol monobutyl ether (average molecular weight: about 500)

[Comparative Example 4] Polyoxypropylene glycol monobutyl ether (average molecular weight: about 1000)

[Comparative Example 5] Polyoxypropylene glycol (average molecular weight: about 1000)

The base oils of Examples 1-2 for the refrigerator oils of the present invention were evaluated for their performances that are their compatibility with HFC-134a, insulating property, wear resistance and hygroscopicity by the following respective test methods. For comparison, the mineral oil, the alkylbenzene, the polypropylene glycol monoalkyl ethers and the polyalkylene glycols disclosed in

U.S. Patent No. 4,755,316 of the Comparative Examples 1-5 which have heretofore been used as refrigerator oils were evaluated in the same manner as in Examples 1-2. The results are indicated in Table 1.

(Miscibility with HFC-134a)

0.2 g of the test oil of each of the Examples and the Comparative Examples and 1.8 g of the refrigerant (HFC-134a) were sealed in a glass tube having an inner diameter of 6 mm and a length of 220 mm. This glass tube was then placed in a thermostat maintained at a predetermined low temperature or high temperature to observe whether the refrigerant and the test oil were miscible with each other, separated from each other or made white-turbid.

(Insulating property)

The test oils were each measured for specific volume resistivity at 25°C in accordance with JIS C 2101.

(FALEX wear test)

The test oils were each applied to a test journal for measuring the amount of the test journal worn by having the journal run in at a test oil temperature of 100 °C under a load of 150 lb for 1 minute and then running it under a load of 250 lb for 2 hours in accordance with ASTM D 2670.

(Hygroscopicity)

Thirty grams (30 g) of each of the test oils were placed in a 300-ml beaker, allowed to stand for 7 days in an air-conditioned bath maintained at a temperature of 60 $^{\circ}\text{C}$ and a humidity of 30 % and then measured for water content by the Karl-Fischer method.

Table 1

Example-Comparative Example	Kinematic viscosity @ 100°C (cSt)	Miscibility with HFC-134a	Resistivity @25°C (Ω·cm)	FALEX test journal worn (mg)	Hygroscopicity 30°C, 60% (%)
<u>Example1</u>	9.6	<-35 - 76 Miscible temperature range (°C)	2.8×10^{14}	20	0.18
<u>Example2</u>	12.7	<-30 - 68	1.2×10^{14}	17	0.12
<u>Com.Ex.1</u>	5.1	Immiscible	3.8×10^{15}	23	0.01
<u>Com.Ex.2</u>	4.8	Immiscible	6.4×10^{15}	25	0.01
<u>Com.Ex.3</u>	4.9	<-70 - 97	1.1×10^{11}	40	1.51
<u>Com.Ex.4</u>	10.8	<-70 - 56	1.2×10^{11}	35	1.01
<u>Com.Ex.5</u>	10.2	-51 - 64	4.8×10^{10}	30	1.81

It is apparent from the results indicated in Table 1 that the refrigerator oils (Examples 1-2) of the present invention are very excellent in miscibility with a refrigerant, HFC-134a, as compared with those of Comparative Examples 1-2.

The polyoxyalkylene glycols of Comparative Examples 3-5 are excellent in miscibility with the refrigerant, but these glycols are inferior in insulating property thereby rendering them unusable for hermetic type compressors. On the other hand, the refrigerator oils of Examples 1-2 are nearly equal in insulating property to the mineral oil and the alkybenzene which have heretofore been used.

The FALEX wear test shows that the refrigerator oils of Examples 1-2 are at least equal in wear resistance to those of Comparative Examples 1-5.

Further, the refrigerator oils of Examples 1-2 have equivalent hygroscopicity to those of Comparative Examples 1-2 and have lower hygroscopicity than the alkylene glycols of Comparative Examples 3-5, that is, the refrigerator oils of Examples 1-2 are excellent in hygroscopicity.

[Effect of the Invention]

As is apparent from the above comparative experiments, lubricating oils for compressors of refrigerators of the present invention are suitable for use in refrigerators using therein a hydrogen-containing halogenocarbon as a refrigerant and are excellent in

electrical insulating property as well as wear resistance
and nonhygroscopicity.